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# ON A RARE DEEP-SEA FISH *NOTACANTHUS PHASGANORUS* GOODE (HETEROMI-NOTACANTHIDAE) FROM THE ARCTIC BEAR ISLE FISHING-GROUNDS

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(*With Plates 7–9*)

## INTRODUCTION

On the 27th of August 1949 the Fleetwood trawler *Wyre General* landed an unusual fish from the Bear Isle grounds. No information is available concerning the depth at which it was taken, but about 100 fathoms may be assumed from our knowledge of the fishery. Messrs. James Mitchell (Port Health Officer) and P. J. Fisher (Chief Sanitary Inspector), who have frequently been instrumental in obtaining rare fishes, kindly forwarded it to the Department of Zoology, University of Liverpool, where it was recognized as a rare *Notacanthus* and presented to the British Museum. The species is *N. phasganorus* Goode, new to the national collections. Only five other authenticated specimens are known, all in American museums, and of these but two have been described and figured.[1]

The holotype (U.S. National Museum, Washington, No. 25972; Goode (1881); Goode & Bean (1894 = 1896)) was taken from the stomach of a Ground-shark, *Somniosus brevipinna* Lesueur = *S. microcephalus* (Bloch & Schneider), on the Grand Bank of Newfoundland, and was partly digested and mutilated about the head. Bigelow & Schroeder (1935) describe a specimen trawled in about 100 fathoms, 20 miles south of Sable Island, which was in good condition except that the viscera had been removed, and the same authors mention a further example from the same locality (Museum of Comparative Zoology, Cambridge, Mass., Nos. 33946 and 35306 respectively).

[1] A large and originally well-preserved *Notacanthus* obtained in Iceland during the voyage of *La Recherche* and figured as *N. nasus* Bloch by Gaimard (1851, pl. XI) and by Cuvier (1836, pl. 55) has been tentatively referred to *N. phasganorus* Goode by Vaillant (1888*b*), who was able to examine the specimen (Musée National d'Histoire Naturelle, Paris, No. A. 6864). One of us (D.W.T.) visiting Paris in October 1950 was told by Prof. L. Bertin that it could not then be found. 'Très probablement a-t-il été détruit à une date ancienne (vers 1889)'. We have little doubt concerning the accuracy of Vaillant's identification, but do not regard the published figures and data available as sufficiently reliable for a critical determination. See Saemundsson (1949) for further discussion and a bibliography of Icelandic material.

In reply to a request for further information on his material Dr. William C. Schroeder disclosed that two more examples have since been taken: M.C.Z. No. 37027 in 420 fathoms at 42° 18′ N., 65° 01′ W., and No. 37037 in 100 fathoms at 44° N., 57° W. Dr. Schroeder is preparing a paper on the species in which these will be described and has kindly allowed us to use such unpublished data as are needed to establish the identity of the Bear Island specimen. We wish also to acknowledge the assistance of Mr. Ernest A. Lachner of the U.S. National Museum who re-examined the holotype for us. The illustrations to the present paper are (with the exception of Fig. 1) the work of Mr. Hubert Williams and the X-ray photographs were taken by Mr. P. E. Purves.

Modern papers by Matsubara (1938) on his *Notacanthus fascidens* and by Trotti (1939) on *N. bonapartei* Risso (based on the examination of 9 and 69 specimens respectively) have largely invalidated the taxonomic distinctions made by earlier workers, especially by Goode & Bean. Matsubara concludes:

'Among the characteristics used in the taxonomy of the fishes of the family Notacanthidae, the number of anal spines and the positions of the insertions and also end points of the fins, which are in reality most variable, are considered to be of most importance. . . .It would be superfluous to say that one must re-examine whether or not each known species belonging to the Notacanthidae is an independent species by taking the above mentioned variabilities into consideration.'

Trotti remarks similarly:

'Concludendo, la grande variabilità del profilo del muso e soprattutto la mancanza di persistenza del rapporto tra dorsali ed anali dure . . . ci porta ad una revisione dei caratteri differenziali dei rappresentanti del genere *Notacanthus* e *Gigliolia*.'

In publishing this full account of the new specimen (British Museum (Natural History), No. 1950.3.30.2) we hope to put on record material of value to such a subsequent revision, and to justify an identification which not only extends the known range of *N. phasganorus* from the western Atlantic to the Arctic but also provides the first published data on the bionomics of the species if not of the genus. But although we now identify our specimen with Goode's species, we are conscious that in the present state of the taxonomy of the genus this name may not be final. There is need of a critical re-examination especially of the material designated *N. chemnitzii* Bloch 1787, *N. nasus* Bloch 1795, *N. phasganorus* Goode 1881, and *N. analis* Gill 1883, the inter-specific differences between which, as at present described, do not seem greater than the intra-specific variation demonstrated elsewhere by Matsubara and by Trotti. It is probable that such a re-examination of the types of these four 'species' supplemented by observations from other material will confirm our suspicion that some or all may be identical. This is no new speculation (see, for example, Lütken, 1898), and it may reasonably be inquired why no precise solution has yet been given. The answer is that apart from the comparative paucity of material, aggravated by its wide dispersal in study-collections, even the type-locality of Bloch's material is not certainly established—though stated by him to have come from the East Indies it has since been believed to have come from Iceland—and the originally bad condition of the holotype has since further deteriorated. (Cf. accounts of Bloch himself, of Cuvier &

Valenciennes (1831), and of Hilgendorf in Goode & Bean (1896).) Even if the specimen in the Berlin Museum is still in existence, it is therefore exceedingly doubtful whether it retains characters adequate for a modern redescription of Bloch's species.

We have no more material relevant to that problem in the British Museum (Natural History), but hope in a subsequent paper to redescribe the types of *N. sexspinis* Richardson 1844 and *N. annectens* Boulenger 1904, and to give accounts of the series of these and related species in our collections as a contribution towards a future full revision. A forthcoming report on the Notacanthidae collected by the Danish *Thor* Expeditions in the north-eastern Atlantic will provide further material.

## DESCRIPTION

Although the body is very well preserved, three factors seriously complicate the usual table of measurements. Firstly the fish is a spawning female, greatly distended by a mass of ripe eggs: as a consequence the vent is widely dilated, blocked by a large plug of ova, and opens posteriorly rather than ventrally, while the postero-lateral walls of the abdomen project as a pair of pouches which partly embrace the vent and conceal the origin of the spinous anal fin. This general distortion of the abdomen renders measurements of body-height of doubtful value. Secondly, the head of the specimen is markedly downturned in a very 'Mormyrid' fashion and more so than in any figure or specimen of a Notacanthid that we have seen. Though there is little support for our opinion forthcoming from other specimens of *N. phasganorus* we are satisfied that the X-ray photograph published as Plate 8 and other considerations (dentition+diet, position of operculum in relation to gill-opening) indicate that this may at least be adopted as a natural attitude, even though it may not be the attitude of rest. Accordingly we give two measurements for body-length and other distances from the tip of the snout to various points; the first represents the measurements with the head forced into line with the body, the second with it *in situ*. Statements of body proportions are based on the former to facilitate comparison with other accounts; the corresponding duplicate set may be computed from the data given if desired. Thirdly, there is some doubt regarding the tail, which may have had the tip broken off and subsequently regenerated a caudal fin. In this case it would be necessary to allow about another 5 cm. on the standard length, plus 2–3 cm. for the caudal fin.

### *Measurements*

| | | | |
|---|---|---|---|
| Total length | 970 mm. | | (950) |
| Standard length | 945 ,, | | (925) |
| Body: | | | |
| Depth at pectoral | 140 ,, | | |
| ,, pelvics | 170 ,, | | |
| ,, vent | 140 ,, | | |
| Greatest depth | 180 ,, | | |
| Greatest breadth | 50 ,, | | |
| Length, snout to vent | 422 ,, | | (402) |

*Measurements* (contd.)

Head:

| | | |
|---|---|---|
| Length | 122 | mm. |
| Greatest depth | 92 | ,, |
| Greatest breadth | 50 | ,, |
| Interocular width | 25 | ,, |
| Length of snout | 35 | ,, |
| ,, postorbital region | 80 | ,, |
| ,, upper jaw | 36 | ,, |
| ,, mandible, to hind end of articular | 39 | ,, |
| Breadth of gape | 41 | ,, |
| Length of maxillary spine | 6 | ,, |
| Diameter of eye | 21 | ,, |
| Longest gill-raker | 6 | ,, |

Dorsal:

| | | | |
|---|---|---|---|
| Distance from snout | 352 | ,, | (350) |
| Length of base | 235 | ,, | |
| Horizontal distance from pelvics | 12 | ,, | |

| | I | II | III | IV | V | VI | VII | VIII | IX | X | XI | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lengths of spines | 1 | 6 | 7 | 8 | 8 | 9 | 11 | 12 | 10 | 13 | 14 | mm. |
| Intervals between spines | 6 | 15 | 20 | 21 | 24 | 23 | 22 | 21 | 14 | 11 | | mm. |
| Length of soft ray | 7 | mm. | | | | | | | | | | |

Anal:

| | | | |
|---|---|---|---|
| Distance from snout | 432 | ,, | (412) |
| ,, vent | 10 | ,, | |
| Length of base | 540 | ,, | |
| ,, spinous base | 230 | ,, | |
| ,, first spine | 2 | ,, | |
| ,, longest spine (XVIII) | 19 | ,, | |
| ,, ,, soft ray | 34 | ,, | |

Pectoral:

| | | | |
|---|---|---|---|
| Distance from snout | 148 | ,, | (139) |
| Length, left | 65 | ,, | |
| ,, right | 56 | ,, | |

Pelvic:

| | | | |
|---|---|---|---|
| Distance from snout | 350 | ,, | (330) |
| ,, base to vent | 70 | ,, | |
| ,, tip | 24 | ,, | |
| Length | 46 | ,, | |

Caudal:

| | | |
|---|---|---|
| Distance from tip to dorsal | 390 | ,, |
| Length | 25 | ,, |

Radial formula D. XI–1; A. XX, 101+; C. 12(?); P. 13; V. III, 7.
Gill-rakers on first arch 3+1+13.
Branchiostegal rays 9.
Vertebrae 185. (Nos. 75 and 80 have double centre.)
(All counts from X-ray photographs.)
Scales along lateral line, about 500.
Scales in transverse series, 31 above lateral line, 58 below.
Pyloric caeca destroyed through decomposition.

Length of the head 7·95 times in the total length; depth at pectoral 6·92; depth at pelvic 5·70; distance from tip of snout to dorsal 2·75; from tip of snout to pectoral 6·55;

from tip of snout to pelvic 2·77; from tip of snout to vent 2·29; tip of snout to anal 2·24; from tip of caudal to dorsal 2·48; base of dorsal 4·12; spinous base of anal 4·21.

Snout 3·48 in head; eye 5·80; postorbital part of head 1·52; upper jaw 3·38; interocular space 4·88; mandible 3·12; pectoral 1·87; pelvic 2·65.

Body elongate, compressed, considerably higher at the pelvics than at the pectorals, even allowing for the distension of the abdomen; the greatest breadth 0·35 the height at the vent; tapering posteriorly into a long slender tail.

Head compressed, shorter than depth of body, 2·46 in the trunk and 3·54 in the length from tip of snout to anal. Snout long, fleshy, 1·4 times the interocular width and 1·66 times the diameter of the eye. Interocular space narrow, strongly convex, 1·19 times the diameter of the eye. Eye covered by semi-transparent skin, lacking an orbital fold. Nostrils close together, much nearer eye than tip of snout, the posterior slit-like, one-third the eye's diameter from the orbit, the anterior opening into a thin-walled tube protected by a small flap. The centres of the eye, of the two nostrils, and the tip of the snout lie on a straight line.

Mouth inferior, broad, gently curved; upper jaw nearly as long as length of snout; maxilla with a posteriorly directed pungent spine on its upper margin, extending to below the middle of the eye. The integument of the mandible forms a labial fold on each side.

Teeth (Pl. 7, fig. 4) in the upper jaw in a single row, 37 on each side, slender, inclining inward, the bases cylindrical, the tips antero-posteriorly flattened and introrse, mesially 3 mm. long, gradating into smaller and simpler lateral ones. Palatines movable vertically with two rows of about 25 rather finer teeth on each side, with sharper markedly introrse tips. Mandible with a complete innermost row of about 30 teeth on each side, resembling those of the upper jaw but more delicate, preceded by two irregular rows of fine aciculate teeth which do not extend as far laterally as those of the main series. All teeth more or less movable. Anteriorly the teeth of the upper jaw bite between the two series of the lower, but owing to the greater radius of curvature the posterior teeth bite outside those of the mandible. The palatine teeth engage with those of the lower jaw. No vomerine teeth.

Gill-openings wide, membranes separate and free from isthmus. Gills four; no pseudobranch visible on superficial examination. Gill-rakers slender, pointed, incurved, well separated, having minute bristles on their inner faces; a little more than half the length of the gill-filaments, the longest 3·50 in the diameter of the eye.

The prominent pores of the lateralis system of the head are distributed thus: 3 in the supra-temporal series, and on each side 5 in the supra-orbital (comprising 2 above the eye, 1 above the posterior nostril, 2 before the anterior nostril), 16 in the infra-orbital and 14 in the preoperculo-mandibular series.

Lateral line gently arched over pectoral, following profile of the back, thence dropping obliquely to one-third the depth of the body over the vent, and further descending nearly to a median position at the point where it disappears two-thirds of the way along the tail. Lateral line pores conspicuous with darkly pigmented lips.

Entire body scaled, even to the lips, except for the hinder margin of the operculum. Scales cycloid, rectangulo-ovate, closely inset in tough sheaths; very small on the head (1·2 × 1·0 to 2·2 × 2·0 mm.), increasing in size posteriorly to a maximum

of 4·5 × 3·7 mm. on the middle of the body, and thereafter becoming progressively reduced until half-way along the tail they equal those of the head.

Pectorals vertically inserted at middle of body-depth, at a distance behind the gill-opening equal to length of own base; bases broad, fleshy, scaled, pedunculate; posterior edge of fin rounded, length slightly more than half length of head.

Pelvics (Pl. 7, fig. 3) closely adjacent, separated by a narrow groove, reaching far short of the vent. Bases fleshy, pedunculate, thickly covered with scales, origin very slightly behind vertical through origin of dorsal, posterior edge rounded. The third pelvic spine has two much smaller ones set against its base, the first of these concealed by skin.

First dorsal spine (Pl. 9, fig. 6) hidden under the skin; last dorsal spine the longest, followed by a recurved soft ray (Pl. 9, fig. 7) set in a fleshy protuberance. There is a slight groove between the bases of the spines and each supports a slight membrane posteriorly which is best developed between the last spine and the soft ray.

The anal commences immediately behind the vent and below the Vth dorsal spine; the XIIIth anal spine lies under the last dorsal. The anal spines are embedded in fleshy tissue (the first completely concealed, Pl. 9, fig. 8), from which successive spines emerge farther and farther.

Caudal (Pl. 9, fig. 9) clearly separated from anal, but lacking a distinct peduncle and probably aberrant owing to regeneration of tip (see p. 75).

*Colour.* Head and body dark brown, tending to be lighter on the forehead and flanks; lips and hinder edge of operculum bluish-black, fin-rays and anal fin dusky. The fish had a glossy, varnished appearance when dry. Peritoneum and stomach and inside of buccal cavity and operculum black, intestine cream.

## COMPARISON WITH SPECIMENS PREVIOUSLY DESCRIBED

The original description of the holotype (Goode, 1881) gives the radial formula D. X; A. XIX (130); C.0; P. (17); V. II, 8–9. Mr. Lachner was asked to re-examine the dorsal, pectoral, and spinous anal fins only, ascertaining whether any concealed spines and rays had been overlooked and whether a count of the pectoral rays obtained by means of an incision across the fleshy base required any modification of the above formula. He finds the right pectoral fin wanting and gives the count for the left: the revised formula now reads:

Holotype: D. X–1; A. XIX, 130; C.0; P. 18; V. II, 8–9.

compared with:

M.C.Z. No. 33946 D. XI–(?); A. XXIV, 127; C. 7; P. 17; V. III, 7.
New specimen, D. XI–1; A. XX, 101+; C. 12(?); P. 13; V. III, 7.

Bigelow & Schroeder give A. XX for M.C.Z. No. 35306. Schroeder, *in lit.*, provides the following additional data:

M.C.Z. No. 35306 P. 16. One soft ray in dorsal.
,, 37027 P. 13. One ,, ,,
,, 37037 P. 16. Two soft rays in dorsal.
,, 33946 Not available for re-examination.

Bearing in mind the known variation in other species we may regard the counts for

dorsal, ventral, and spinous anal fins as giving an adequate agreement.[1] The range of variation in the pectoral (13–18) is remarkable, however, even compared with Trotti's counts for *N. bonapartei* (12–14) and Matsubara's for *N. fascidens* (12–15). The discrepancies in the counts given for the caudal in part reflect the curious misunderstanding which has surrounded the problem of the tail structure in this group. The diagnoses of Goode & Bean (1894) contain mutual contradictions:

*Fam. Notacanthidae.* 'Anal fin . . . extending . . . to the caudal with which it unites.'
*Notacanthus.* 'No caudal', although under the same generic diagnosis *N. sexspinis* is given a count of C. 5. In the accounts of the various species several numbers are given, including *N. phasganorus* with C.o.

Regan (1929) gives:

*Order Heteromi.* 'A long tail, with a long anal fin below it, tapering to a point, without caudal fin.'

While the relations of anal and caudal are certainly difficult to ascertain in these fishes and really call for radiographs and alizarin preparations for their proper elucidation, there can be no doubt that many previous descriptions made before the use of the binocular microscope became *de rigueur* will prove to be erroneous when the material is re-examined.

The present specimen shows a distinct separation between the caudal and anal rays, more easily studied in an X-ray photograph (Pl. 9, fig. 9), which shows at least 12 caudal rays. But the structure is markedly different from that of the tails of other species which we have examined, which are symmetrical, having a distinct though small caudal peduncle, already described and figured in *N. phasganorus* by Bigelow & Schroeder (1935). The appearance presented in our figure suggests that the tail has lost its tip at some time and subsequently regenerated a caudal fin.

Since Goode almost certainly included the caudal rays in his count for the anal fin (130) we should do likewise to obtain a comparison, and so have 134 for the fish described by Bigelow & Schroeder and 113+ for the new specimen. A truncation of the tail would also account for this lower number.

Gaimard's (1851) figure of the *La Recherche* specimen evidently represents a tail even more markedly truncated (Vaillant, 1888*b*) and again with a regenerated caudal fin. It seems that this condition is not uncommon in *Notacanthus*.

[1] Vaillant's (1888*b*) data, supplemented by counts from Gaimard's (1851) plate, give the radial formula:

D. XI–1; A. XXII, 92+; C. 8 (?); P. 16; V. III, 8

for the *La Recherche* specimen, which therefore comes within the known range of *N. phasganorus*.

For further comparison the following counts all purport to have been taken on the holotype of *N. nasus* by Bloch (1795), Cuvier & Valenciennes (1831), and Hilgendorf for Goode & Bean (1896) respectively:

D. X; A.+C. XIII, 136; P. 16; V. II, 8.
D. X–O; A. XIII, 116; C. 8; P. 17; V. I, 8.
D. XI; A. XV, 118; C. ?; P. 19; V. III, 7 (l), 8 (r).

There seems to be little useful purpose in attempting to decide the relation between *N. nasus* and *N. phasganorus* on such data, except to remark that the only serious discrepancy, the consistently low count for the spinous anal, must be considered against the range of A. IX–XVIII demonstrated by Trotti (1939) in *N. bonapartei*, and the anterior fin-structure shown in our Pl. 9, fig. 8.

## ANATOMY

Those skeletal features discernible from X-ray photographs agree with the very full accounts given by Günther (1887) for *N. sexspinis* and Vaillant (1888*a*, *b*) for *N. mediterraneus*. Vaillant gives the more detailed account of the general anatomy. The viscera in the present specimen are in general poorly preserved, but it is possible to supplement these descriptions in certain details.

The spacious body-cavity is very high, and extends posteriorly considerably behind the anus, to the level of the seventh anal spine. The kidneys are large, the deep anterior lobes flanking the rectum and not extending farther forward in any

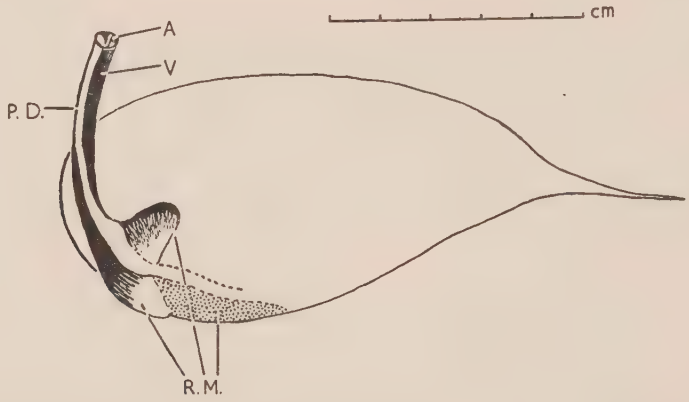


FIG. 1. Gas-bladder from left side. P.D., pneumatic duct; A. and V., artery and vein supplying bladder; R.M., retia mirabilia. The dotted portions indicate the extensions of the pneumatic duct and of one rete within the bladder.

bulk, while the remainder of the kidneys extend back along the roof of the post-anal body-cavity. There is no urinary bladder preserved. The undivided liver, the gonads, and the alimentary canal appear to agree with previous accounts, but the gas-bladder shows some marked differences and merits fuller treatment. Whether the discrepancies are due to interspecific variation or to inaccuracies of description cannot be stated.

The gas-bladder (Fig. 1) is oval in shape with a small blind posterior prolongation, and lies above and extends slightly before the ventral fins. It is suspended in a fold of mesentery with a rather stronger attachment posteriorly; the bulk of it being free anteriorly sags down into the body-cavity. The tunica externa comprises the usual two easily separable layers: an outer thin, tough, white, and muscular and an inner very dense and silvery, containing elastic fibres. The tunica interna comprises a substantial basis of dense connective tissue supporting a poorly preserved series of muscular, vascular, and columnar epithelial layers. The lumen of the bladder contains a quantity of granular yellow matter.

There is a fairly long pneumatic duct which does not approach anywhere near the oesophagus. Along it run the artery and vein supplying the bladder, and a number of streaks of yellowish tissue interpreted as pancreas. The vessels break up into two retia mirabilia before approaching the bladder with the pneumatic duct on the lower

left side, the combination of these structures forming a laterally compressed body which Günther regarded as a left 'cornu' of the bladder, the retia evidently being identical with his 'pair of thick muscle-like pads'. The pneumatic duct opens in the centre of the floor of the bladder towards the anterior end. The retia are of the 'rete mirabile unipolare duplex' type (Woodland, 1911, 1911*a*), since dissection does not reveal any recombination of capillaries to form major vessels before they enter the gas-gland. The gas-gland is a small patch of spongy vascular tissue surrounding the entrance of the pneumatic duct from which similar tracts radiate over most of the lining of the bladder. The postero-dorsal portion of the bladder has a thinner, smoother lining epithelium which probably represents a fully dilated oval (Woodland, 1913).

## BREEDING

Though the precise date of capture is not available it may be assumed that the fish was taken about mid-August, and that the breeding season in Bear Island waters is therefore about that time.

The ova, entangled in fibrous tissue, were opaque white when received and slightly elliptical, ranging from 1·20 × 1·30 down to 1·16 × 1·25 mm. diameter. They thus provide a further instance of aspherical teleost eggs to be added to those discussed by Breder (1943). They contain many small colourless oil droplets, 10–70$\mu$ in diameter.

## FOOD AND FEEDING

The stomach was well filled with the remains of some two dozen pink and magenta-coloured Actiniarians, comprising the tops of several small anemones of 1–2 cm. diameter and pieces apparently bitten from the rims of much larger ones. In some cases it was possible to distinguish scapus and scapulus; all the fragments were more or less heavily tuberculated and bore traces of a dehiscent cuticle.

A consideration of structure in relation to diet leads to some interesting conclusions.

1. The dentition and shearing bite of the jaws are admirably suited to feeding on Actiniarians. What would, on theoretical considerations, seem the ideal shape of the head and position of the mouth? A terminal mouth would require the fish to stand on end in the water when feeding, a rather unlikely proceeding, or to perform movements like those of the Lemon Dab *Pleuronectes microcephalus* Donovan which removes tubicolous polychaetes from their burrows by 'bringing its mouth down almost vertically upon its victim by a strong arching of the anterior part of the body' (Steven, 1930). (The same species in the southern North Sea feeds largely on *Cerianthus* sp.; Todd, 1907.) This last movement is hardly possible to a stout-bodied fish such as our *Notacanthus*. There remains only the combination of an inferior mouth with what degree of flexure can be attained, the condition in fact which is illustrated in Pl. 8, where there is a marked downturning of the vertebral column bringing the jaws into the best position for horizontal and near-horizontal biting. From these considerations, accompanied by the fact that there is no indication of any fracture or dislocation of the skull and pectoral region, we believe that the head of our specimen is in fact being carried in a normal position, though whether this is facultative or permanent cannot be decided.

2. The pieces of anemones present fall, as we have noted, into two size-groups, those from very small and very large individuals. The absence of remains of medium-sized ones suggests that such animals are possibly too large to be taken entire and yet too small to allow the fish to take a bite because the curvature of their body surface is so sharp that the jaws at maximum gape cannot obtain sufficient hold. With larger anemones it becomes possible to take a bite from the rim.

3. Günther (1887) remarks of *N. sexspinis*:

'The osseous framework of this fish is so much wanting in the characteristic peculiarities of bathybial fishes as to throw serious doubts that this species at least of *Notacanthus* lives at a great depth.'

The evidence from radiographs indicates that the skeleton of *N. phasganorus* is substantially similar, and its gas-bladder is better developed than in oceanic fishes. But from its diet and the related structural adaptations it is clearly a bottom-feeding form, and it is therefore probable that specimens taken have been obtained on or near the bottom, so that a bathymetric distribution of 100 to at least 420 fathoms may be deduced from the records so far available. *N. mediterraneus* Fil. & Ver. is evidently another bottom-feeding form; Vaillant (1888*b*) records hexactinellid sponge spicules from a specimen taken by the *Talisman* from more than 1,200 metres.

Actiniarians have been reported as of frequent occurrence in Cod stomachs obtained from Bear Island and the Murman coast (Brown & Cheng, 1946); off Greenland, where Cod from deep water off Nuk feed almost entirely upon them (Jensen & Hansen, 1931), and in Danish waters (Blegvad, 1916). Stephenson, in Brown & Cheng, loc. cit., provisionally identified their material as *Hormathia digitata* (O. F. Müll.), *H. nodosa* (Fabr.), and *Tealia felina* (L.) var. *lofotensis* (Dan.). Some of our material may be referable to *Hormathia* spp., but precise identification would be extremely difficult if indeed possible.

## PARASITES

The gills, alimentary canal, and peritoneum lining the body-cavity have been examined for parasites, but none have been found.

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## PLATE 7

FIG. 2. *Notacanthus phasganorus* Goode; Bear Island specimen.

FIG. 3. Detail of right pelvic fin, from below.

FIG. 4. A, underside of head; B, side, and C, D, front views of teeth of maxillary series; E, palatine tooth.

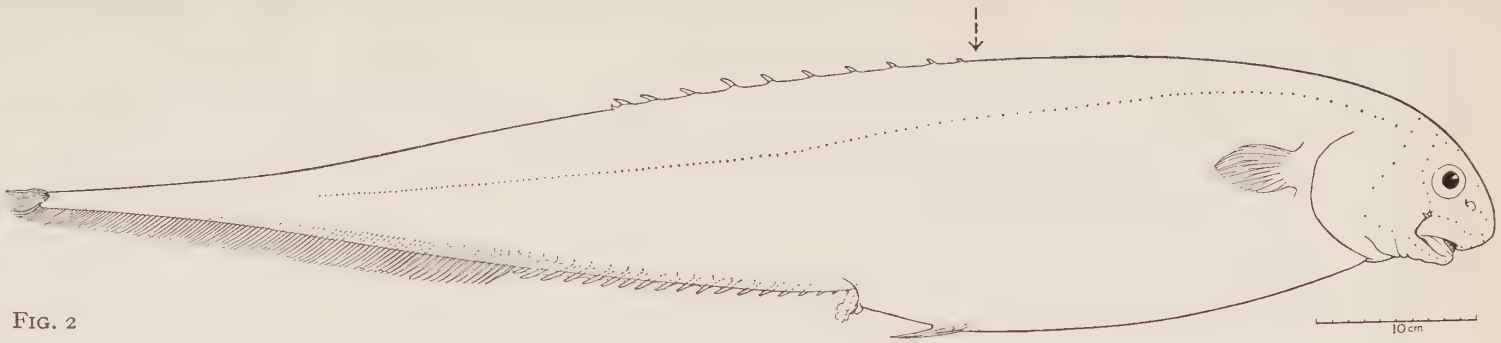


FIG. 2


FIG. 3

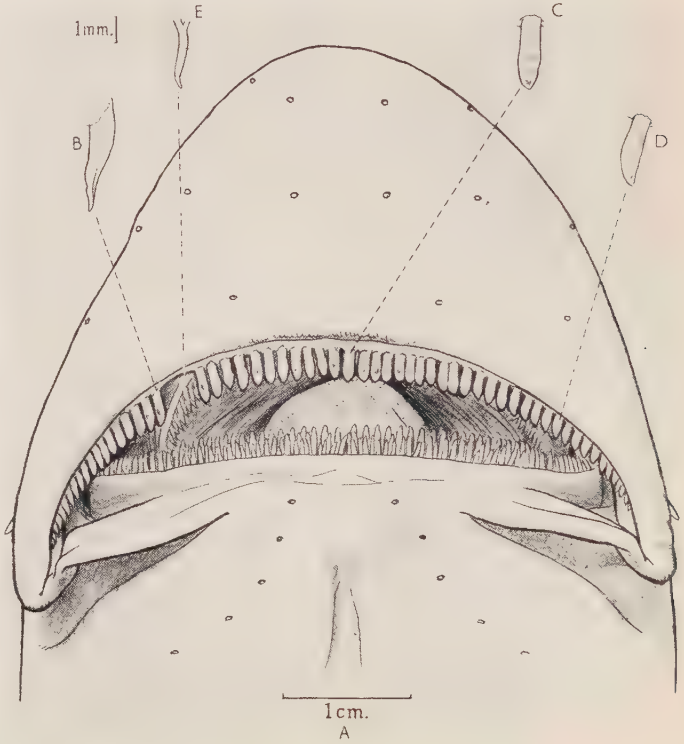


FIG. 4

NOTOCANTHUS PHASGANORUS

## PLATE 9

FIG. 6. X-ray photograph of origin of dorsal fin.

FIG. 7. X-ray photograph of end of dorsal fin. I, II, &c., spines; R, soft ray.

FIG. 8. X-ray photograph of pelvic region, showing pelvic fins and girdle. AI, first spine of anal fin.

FIG. 9. X-ray photograph of end of tail.

(Figs. 2–4, scale indicated on drawing; Figs. 5–8, ×1; Fig. 9, ×2.)

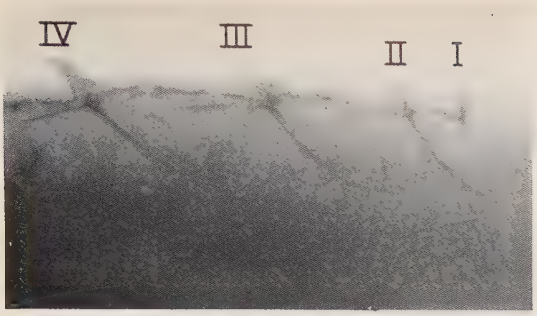


FIG. 6

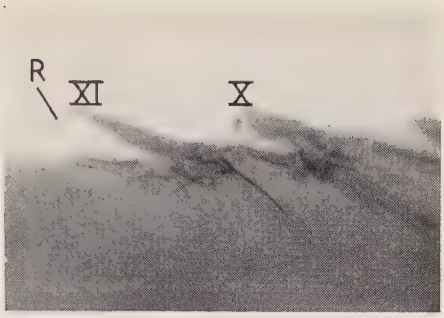


FIG. 7

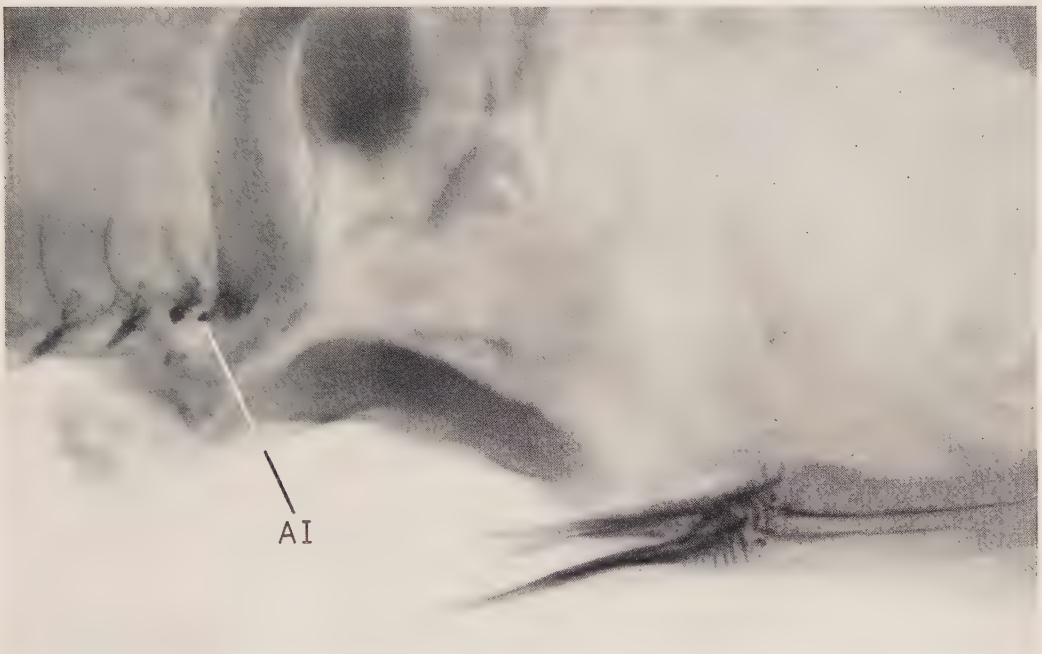


FIG. 8

FIG. 9

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